

REPORT
OF
THE SECRETARY OF THE TREASURY,

COMMUNICATING

(In compliance with a resolution of the Senate)

*The result of an experiment to ascertain the expediency of using gas,
instead of oil, in the light-house establishment.*

MAY 24, 1844.

Read, and referred to the Committee on Commerce.

MAY 28, 1844.

Discharged.

MARCH 3, 1845.

Ordered to be printed.

TREASURY DEPARTMENT, May 23, 1844.

SIR: In obedience to a resolution of the Senate, dated the 18th instant, instructing the Secretary of the Treasury to communicate "the result of an experiment made at the Christiana light-house, for the purpose of ascertaining the expediency of using gas instead of oil in the light house establishment, stating the relative cost of the same, and the opinion of the department on the subject," I have the honor to transmit copies of letters from B. F. Coston and Captain Henry Prince, jr., showing the results of the experiments referred to in the resolution.

A copy of a letter from S. Pleasonton, Esq., together with copies of certain papers therewith transmitted, showing the measures taken more fully to ascertain, by further trial, the relative cost of gas as compared with oil, and the opinions of experienced men on that and other points connected with the general use of gas as a substitute for oil, are also enclosed.

The conflicting views presented in the papers thus enclosed suggest caution in the expression of any definite opinion. Thus far, the experiment has certainly been encouraging; but until the results of the further use of gas, in the experiments now in progress, are known, the department can form no satisfactory conclusion.

I have the honor to be, very respectfully, sir, your obedient servant,

McCLINTOCK YOUNG,

Secretary of the Treasury ad interim.

Hon. W. P. MANGUM,

President of the Senate.

WILMINGTON, *May 16, 1844.*

SIR: In compliance with the instructions of the Secretary of the Treasury, contained in his letter of the 10th of November, 1843, in reference to the light-house at Christiana creek, I have the honor to inform you that I have completed the work, and to my entire satisfaction. The light-house is now lighted by gas, and is in successful operation.

I beg leave to refer you to the report of Captain H. Prince, of the revenue marine, a copy of which is hereto annexed, in furtherance of the orders of the Treasury Department of the 25th of April last, where, somewhat in detail, the principles of my experiment and the extent of my success are explained.

The result of this experiment has enabled me to establish the following comparison:

The most accurate computation of the cost of lighting the light-houses with oil, agreeably to the plan now in general use, is at an average of one dollar per night for every ten lamps.

The cost of gas light, agreeably to my plan, is twenty cents per night, and the amount of light given is three times as great as from oil, each gas burner being equal to three of the best light-house lamps.

I beg leave here to remark, that this practical test of my theory of lighting light-houses has more than confirmed all my anticipations, and has met with the undivided approval of all who have seen and examined this light. The want of elevation in the Christiana light-house, being only 47 feet from the surface of the water to the light, and the insular locality of the site, not having in any one direction a sufficient continuous range of vision to show the light to the fullest extent of its beneficial results, deprive this experiment of some of its advantages.

To give to this experiment a more enlarged and thorough test, I should be particularly gratified to have the experiment tried upon the unoccupied tower on the highland of Neversink, where a comparison could be made with the French lenses now used there and the gas light upon my plan of construction. This could be done at a cost to the Government of about one thousand dollars; and, from the advantages of the great elevation of the light, the uninterrupted range out at sea to an indefinite extent, and on that great commercial highway, a full, thorough, and unembarrassed test could be made, that would involve the relative cost of construction, quality, quantity, and expense of the light, and every thing necessary to institute a comparison of the present system of lighting light-houses with the plan that I propose.

I therefore most respectfully ask to be employed in carrying out this experiment.

Most respectfully, your obedient servant,

BENJAMIN F. COSTON.

McCLINTOCK YOUNG, Esq.,

Secretary ad interim.

CHRISTIANA CREEK LIGHT-HOUSE, *May 1, 1844.*

In obedience to the order of the Hon John C. Spencer, Secretary of the Treasury, the subjoined report of the examination of the light-house on Christiana creek, Delaware, under the superintendence of the Hon. Ar-

nold Naudain, collector for the port and district of Wilmington, is respectfully submitted for the consideration of the department :

REPORT.

Of the lantern and apparatus.

Height of the lantern above the surface of the river, forty-seven feet ; diameter of the lantern, six feet ; height from the deck, six feet ; form octagon, with fifteen panes of glass on each side. It contains ten gas burners and ten reflectors of fifteen inches in diameter, and ten feet of half-inch iron pipe, for the arms of the burners.

Apparatus of the gas work.

Diameter of the gasometer, ten feet ; depth of the gasometer, ten feet—of iron, weighing fourteen hundred and fifty pounds, and contains seven hundred and fifty cubic feet of gas. The cistern, of wood, ten feet and six inches in diameter, and eleven feet in height. The retort is three feet six inches long, one foot six inches wide, and eight inches deep—and will probably require an annual renewal. The furnace is four feet high and four feet long. The rosin kettle is eighteen inches deep and sixteen inches in diameter. The condenser, of iron, four feet long, one foot high, and one foot wide. Six wrought-iron pipes, three inches in diameter, and ten feet high. Sixteen feet of three-inch pipe, conducting to the gasometer. Sixty-six feet of one-inch pipe, conducting to the lantern. Twenty-seven feet of half-inch pipe, conducting to the rooms of the dwelling. Four pulleys, with thirty feet of chain attached to fifteen hundred pounds weight, to suspend the gasometer. The tar pump, of iron. The tar cistern, of brick, three feet long, two feet wide, and three feet deep. Proof of the pipes, two hundred pounds to the square inch. Pressure of the gas on the pipes, three-quarters of a pound to the square inch.

Of the danger of using gas.

My own opinion of the using of gas is, that it may be attended with some danger from fire in wooden buildings, but no greater than that created by the fires used for warmth or culinary purposes. In buildings constructed with brick, stone, or iron, there cannot exist any danger whatever.

Amount of gas consumed.

About one pound of anthracite coal per hour, at a cost of one-fourth of a cent. The same weight of coke per hour, at a cost of one-fifth of a cent. About two and a half pounds of rosin per hour, at a cost of two-fifths of a cent.

HENRY PRINCE, JR.

DELAWARE BAY,

*On board the revenue marine schooner "Forward,"
John A. Webster, Esq., Commander.*

Of the intensity of the light.

The comparative intensity of light, as ascertained by the pholometer at the light-house, was, by the gas light, seven and one-half inches; by the oil light, four and one-half inches; or the same degree of light was produced by the gas light, at a distance of seven and one-half inches, as by the oil lamp at four and one-half inches.

May 2, at 7½ P. M.—Christiana Creek light bearing north by east, half east, about eleven miles distance. Reedy Island light bearing south, half east, about five miles distance. Christiana light of much greater power than Reedy Island light. Wind south, rainy weather. At 2½ A. M., the light at Christiana of twice the intensity as Reedy Island light. Moonlight; dark horizon. May 3, at 8 P. M.—Chester, northwest, 150 fathoms. Christiana light very brilliant; estimated distance, twelve miles. At 3 A. M., bright moonlight; the light very brilliant.

May 4, at 6 minutes past 9 P. M.—The Lazaretto, east by north, half north, two miles; estimated distance from Christiana, fourteen miles; the light brilliant; wind southerly; clear weather. At 3 A. M., the light visible; wind southerly; hazy weather.

Not being in possession of an accurate chart of the Delaware bay, the distances from the several positions of the "Forward," from near Reedy island, Chester, and the Lazaretto, are estimated, and agree with the opinion of the pilots and others navigating in the bay.

	Statute miles.
In the table for finding the distance of terrestrial objects at sea, the radius of vision for forty-seven feet (the height of the lantern on Christiana creek above the surface of the river) is	9.07
Height of the eyes of the observer, from the deck of the "Forward," above the surface of the river, 9 feet, or	3.97
	<hr/> 13.04 <hr/>

The increased distance of two miles, at which the light was visible from the deck of the "Forward," near the Lazaretto, was probably produced by the action of refraction.

From the intervention of the points of land between the "Forward" and the light, longer distances up or down the bay were not available.

The department will be pleased to allow me to express my obligation to Captain Webster of the "Forward," and to Mr. Benjamin F. Coston, for their kind assistance in the afore-mentioned examination.

Sir, I am, with great respect, your obedient servant,

HENRY PRINCE, JR.,
Captain Revenue Marine.

HON. JOHN C. SPENCER,
Secretary of the Treasury.

BALTIMORE, May 9, 1844.

TREASURY DEPARTMENT,

Fifth Auditor's Office, May 22, 1844.

SIR: I had the honor this morning to receive your note of yesterday's date, enclosing a copy of a resolution of the Senate of the 18th instant, calling upon the Secretary of the Treasury for information as to the result of an experiment made at the Christiana light-house, for the purpose of ascertaining the expediency of using gas instead of oil in the light-house establishment, and the relative cost of the same, with the opinion of the department upon the subject.

The gas light at the Christiana light-house has been so recently put into operation, (only on the 11th of last month,) that sufficient time has not been allowed to test its economy, as compared with oil light, or the expediency of its adoption in that or other light-houses; and consequently the superintendent, Mr. Naudain, has made to me no report of the expense of generating the gas, though he has reported the light to have been greatly increased in brilliancy and power. Nor does Captain Prince state, in a report from him now in my possession, and of which I herewith transmit a copy, the cost of the gas in a satisfactory manner. I have instructed Mr. Naudain to cause an accurate account of the expense of the necessary quantity of gas for supplying the light to be kept continuously throughout the year, to be reported to this office monthly, in which will be comprehended the short and long nights, as well as the various seasons which may have an influence on the consumption. We shall thus be enabled, not only to ascertain the expense of the gas, as compared with that of oil, but whether the apparatus can be managed by one keeper, and it be sufficiently durable and safe to recommend it to general use.

We should adopt this change in our light-houses with extreme caution, and not until full and ample experiments shall have shown its safety and utility; for wherever it has been tried in Europe for light-house purposes, it has been condemned. For the propriety of this course, it may be useful to refer to the testimony of Robert Stevenson, Esq., and Mr. McConnica, contained in a report upon light-houses, made by the House of Commons, in England, in 1834, herewith enclosed; and to two letters from Mr. Mowton, secretary of the gas company in Baltimore, of the 23d and 28th of November last, in answer to inquiries from this office, and of which copies are enclosed, and in which the opinions of that company adverse to the employment of this light are fully expressed.

I have the honor to be, respectfully, sir, your obedient servant,

S. PLEASANTON.

McCLINTOCK YOUNG, Esq.,

Secretary of the Treasury ad interim.

Extracts from "Minutes of Evidence taken before the Committee of the House of Commons on Light-houses, April, 1834."

Quest. 2131. What is the result at the present moment of all your observations as to the most economical and best light that can be used? Consider them well.

Ans. In the present state of my information, the result that I have come to

is, that the simple argand burner and reflector, as now used, is, on the whole, the most economical and the most manageable of any of the other systems of lighting with oil. The gas I think a very uncertain mode of lighting an establishment of that kind. When I visited Holyhead in October last, I found the gas-house partly unroofed; they had an explosion just a day or two before I arrived, and that had been the third accident they had had; one man had been killed, others narrowly escaped. It would therefore require to be introduced with great caution upon the coast. There may be preventive means, but there is certainly, under all circumstances, great danger.

Quest. 2132. The danger to which you allude would be lessened, were the reservoirs at a distance from the light-house, and not likely to affect it in case of explosion?

Ans. It would; but it would be necessary to increase the number of light keepers. Accidents of that kind might kill the keepers, were they near the apparatus.

Quest. 2133. Is oil gas attended with that danger?

Ans. It is oil gas that is in use at Holyhead, and which I am speaking of.

Quest. 2134. Do you know the immediate cause of the explosion that took place at Holyhead?

Ans. The explosion that happened in October last, before I reached Holyhead, was owing to one of the gasometers being somewhat leaky; it was emptied of the gas for repair; but it had not been sufficiently emptied, because, on approaching it with a candle, to examine it, it exploded.

Quest. 3127. You are not aware whether any other experiments have been made on any new lights?

Ans. The substitution of gas instead of oil was suggested to us by Sir David Brewster, and we sent our engineer to Holyhead, where it is now employed; but we found that some accidents had taken place, and that an explosion had very recently occurred, by which the roof of the gas-house had been blown off and a man killed. We thought that the substitution of gas might probably have led to a reduction of expense; but, finding that so serious an accident had taken place, we were very much discouraged from employing it.

CUSTOM-HOUSE, BALTIMORE, *November 23, 1843.*

SIR: Referring to my letter of the 21st instant, I have now the honor to enclose you a letter addressed to me by Mr. James Mowton, secretary of the gas light company of this city. Mr. Mowton is well acquainted with the subject on which he writes, and the information which he imparts may be regarded as entirely accurate.

Very respectfully, I am your obedient servant,

N. F. WILLIAMS,

Superintendent of Lights.

S. PLEASANTON, Esq.,

Fifth Auditor, Washington.

OFFICE OF THE GAS LIGHT COMPANY OF BALTIMORE,

Baltimore, November 22, 1843.

SIR: I do not perceive that I can, from the data you have furnished me, ascertain "what would be the cost of gas made from coal, and the cost of it made from rosin, for 15 lamps or jets an entire year," inasmuch as the size of the lamps or jets is not given; and the size, it is manifest, must form an essential element in the calculation.

But I presume that the object of the Fifth Auditor, in making the inquiries contained in his letter to you of the 18th instant, will be fully accomplished by stating that 200 cubic feet of coal gas, specific gravity 400, yields as much light as a gallon of best sperm oil, and would cost 40 cents. That 130 cubic feet of rosin gas, specific gravity 650, is also equal to one gallon best sperm oil, and would cost 52 cents. The cost of manufacturing the respective gases is given from the experience of the New York Gas Company, which makes rosin gas, and of our company, where coal gas is made. It would certainly not cost less to make these gases on a small scale, and might probably cost more.

As to the dangers of explosion:

Gas itself cannot explode. It is well known that the combination of certain proportions of gas and of atmospheric air forms the explosive mixture. This combination cannot take place, unless the gas be permitted to escape without combustion for a considerable time; a circumstance which could not well occur without the most culpable negligence on the part of the superintendent.

Very respectfully,

JAMES MOWTON, *Secretary.*

NATHANIEL F. WILLIAMS, Esq.

CUSTOM-HOUSE, BALTIMORE, *November 28, 1843.*

SIR: I had the honor to receive, yesterday, your letter dated the 25th instant, which I lost no time in handing to Mr. James Mowton. From that gentleman, I have this morning received the enclosed answer, which I believe will be found satisfactory, to all the questions propounded to him.

With great respect, I am your obedient servant,

N. F. WILLIAMS,

Superintendent of Lights.

S. PLEASANTON, Esq.,

Fifth Auditor, Washington.

OFFICE OF THE GAS LIGHT COMPANY OF BALTIMORE,

Baltimore, November 27, 1843.

SIR: I am favored with yours of this date, enclosing a letter from the Fifth Auditor to you of the 25th instant, and requesting me to give you "my opinion on the several questions asked in that letter."

The first question asked is, "would not the cost of producing either of these gases [rosin or coal] be increased considerably, by causing them to be made at the light-houses in small quantities?"

My opinion is, that the cost of making gas would be somewhat greater in small quantities than in large. Probably 25 or 30 per cent. would cover the difference.

The second question propounded to me is, "would ignorant men, such as we generally employ as keepers, be competent to make the gas safely and properly, at each light-house?"

To this I reply, that men ignorant of gas making could not be safely trusted to manage the apparatus proper for generating, purifying, and distributing gas. Persons who are intended for that employment would require considerable preparatory training.

If the light for light-houses be supplied from gas, it will follow as a necessary consequence that light-house keepers will have to be appointed from among those who have acquired a knowledge of the mode of generating gas by working at factories; or else there will have to be a man employed, other than the keeper, at each light-house, possessed of the requisite knowledge and experience; otherwise, the process could not be safely and properly carried on.

When the gas is made and conveyed to the burners, no accident could take place, unless it be suffered to escape without combustion; a circumstance not at all likely to occur, unless from flagrant neglect. But Mr. Pleasonton will not fail to perceive that this opinion as to the safety of using gas, after it is made, does not at all conflict with the opinion that the apparatus for generating and purifying gas could not be safely intrusted to a man without experience in the use of that apparatus.

My opinion is also required as to whether it [gas] would answer for our light-houses generally.

I have not the least hesitation in saying that, in my opinion, gas is not a suitable article to use for the illumination of light-houses; and whatever degree of success might attend the experiment in cases peculiarly favorable, yet the general result would be utter failure.

I am, very respectfully, your obedient servant,

JAMES MOWTON.

NATHANIEL F. WILLIAMS, Esq.,

Collector, &c.

TREASURY DEPARTMENT, *May 25, 1844.*

SIR: In further answer to a resolution of the Senate, dated the 18th instant, having reference to the comparative cost and advantages of gas as a substitute for oil in the light-house establishment, I have the honor to transmit a letter from the Fifth Auditor, with the accompanying papers, which were received this morning.

I am, very respectfully, sir, your obedient servant,

McCLINTOCK YOUNG,

Secretary of the Treasury ad interim.

Hon. W. P. MANGUM,

President of the Senate.

TREASURY DEPARTMENT,
Fifth Auditor's Office, May 25, 1844.

SIR: I received this morning a letter from Mr. Naudain, the superintendent of the light-house at the mouth of the Christiana river, in Delaware, in relation to the gas light lately put into operation in that light-house, of which I herewith enclose a copy, and beg the favor of you to transmit it to the Senate, as connected with the inquiry contained in their resolution of the 18th instant.

I have the honor to be, respectfully, sir, your obedient servant,
S. PLEASANTON.

McCLINTOCK YOUNG, Esq.,
Secretary of the Treasury ad interim.

SUPERINTENDENT'S OFFICE,
Wilmington, Delaware, May 23, 1844.

SIR: Your letter, dated the 20th instant, requesting the amount of expenditure incurred in fitting up the Christiana light-house for making and burning gas instead of oil; and also "in regard to the expense of conducting this light, in comparison with that attending the oil light, as used in the argand lamp."

The first branch of information sought I am now unable to furnish; the bills of expenditure have not yet been furnished to me. I understand they are at this time in Washington, under the inspection of the Secretary of the Treasury.

In accordance with your instructions to that effect, I issued instructions to the keeper of Christiana light, to keep an exact account of all the materials used in the manufacture of gas, and to make a monthly return. He began to keep this account on the first day of May. I have now the honor to transmit you his account for 22 days of this month, which is all that can yet be furnished. The aggregate value of materials consumed for gas to burn 10 lights for 22 nights is \$3 58, being nearly 16½ cents per night for 10 lights, or rather more than 1½ cent each light per night. In this district we have five 10-light light-houses, viz: Bombay Hook, Mahon's, beacon at Cape Henlopen, Egg Island, and Cohanzey. The average consumption of these lights for the second quarter of 1842-'3 was 3 quarts each night; this, for 22 nights, would be 16½ gallons, and at 90 cents, the present price of oil, would amount to \$14 85, or 67½ cents per night.

But the intensity of the light from gas is so great that as good a light, perhaps better, would be furnished by one-half the number of burners that are used with oil. This would make the comparative expense for the same amount of light furnished by gas only one half of the above statement.

This statement, although the result of a very brief experiment, is believed to embrace all the materials actually consumed in the manufacture of the gas consumed in 22 nights at the Christiana light-house, and the comparison fairly made with the other 10-light light-houses in this district.

I have the honor to be, most respectfully, your obedient servant,
ARNOLD NAUDAIN, *Superintendent.*

STEPHEN PLEASANTON, Esq., *Fifth Auditor, &c.*

CHRISTIANA LIGHT-HOUSE, *May 22, 1844.*

Amount of materials used at the Christiana light-house from May 1 to May 22, 1844.

2 barrels of rosin, 90 cents per barrel	-	-	-	\$1 80
2½ bushels coal, 16 cents bushel	-	-	-	40
14½ bushels coke, 6¼ cents per bushel	-	-	-	91
½ bushel clay, 50 cents per bushel	-	-	-	25
1 yard muslin, 10 cents per yard	-	-	-	10
1½ pound soap, at 8 cents per pound	-	-	-	12
				<u>\$3 58</u>

BENJAMIN A. CROZIER, *Keeper.*

TREASURY DEPARTMENT, *February 17, 1845.*

SIR: In further answer to the resolution of the Senate, dated 18th April last, on the subject of the experiment made at the light-house at Christiana river, for the purpose of testing the advantages of gas as a substitute for oil in the light-houses, I have the honor to enclose herewith—

1st. Letter from S. Pleasonton, Esq., Fifth Auditor, &c., dated December 30, 1844, accompanied by the report of a commission appointed to investigate the subject.

2d. Reply to the report of the commissioners, by Benjamin F. Coston.

3d. Report on the same subject, from A. Naudain, Esq., collector and superintendent of the lights in the district of Delaware.

With the view of further testing the advantages resulting from the substitution of gas, the department has authorized the light-houses at Egg island, Reedy island, and Cohanzey creek, to be provided with the necessary fixtures and apparatus for the use of gas.

I am, very respectfully, sir, your obedient servant,

GEORGE M. BIBB,
Secretary of the Treasury.

Hon. W. P. MANGUM,
President of the Senate.

TREASURY DEPARTMENT,

Fifth Auditor's Office, December 30, 1844.

SIR: On the 22d May last, I addressed a letter to the acting Secretary of the Treasury, in pursuance of a resolution of the Senate of the 18th of that month, calling for the result of an experiment made at the Christiana light-house, for the purpose of ascertaining the expediency of using gas instead of oil in the light-house establishment, in which it was stated that sufficient time had not then elapsed to afford the information required.

Keeping in view the object of the resolution, I recently instructed the superintendent at Wilmington, Delaware, to ask the favor of three scientific and disinterested gentlemen to repair to the light-house, and to report their opinion as to the fitness of gas for light-houses, its advantages and disadvantages, and its cost in relation to other kinds of light, and particularly whether, from the explosive nature of gas, it would be advisable to adopt

that mode of lighting our light-houses. They were also requested to state whether the mode of producing gas at the Christiana light-house was an improvement, and, if so, in what it consisted.

The superintendent accordingly invited three gentlemen, all distinguished for scientific knowledge, and some of them practically acquainted with the production and all the properties of gas made from different materials, viz: Messrs. Walter R. Johnson, John C. Cresson, and George W. Smith, to undertake this duty; which they obligingly did, without compensation. Having repaired to the light-house, and made the necessary examination, they transmitted to this office, through the superintendent, the full, able, and interesting report, of which I have now the honor to enclose a copy, with the request that you will transmit the same to the honorable Senate of the United States.

Mr. Johnson, being in this city subsequently to the date of the report, and being furnished by me with a report made by a committee of the House of Commons upon the Bude light introduced into their chamber by Mr. Gurney, has addressed to me an interesting letter founded upon that report, and as connected with the inquiry relative to the gas light at Christiana. A copy of that letter, dated 24th December, is annexed to the principal report.

I have the honor to be, respectfully, sir, your obedient servant,

S. PLEASANTON.

HON. GEORGE M. BIBB,

Secretary of the Treasury.

Reply to the report of the committee appointed to examine the gas light at Christiana creek, by Benjamin F. Coston, U. S. N.

In looking over the report of the board, appointed by the Fifth Auditor of the Treasury Department, to examine the gas light at Christiana creek, in the State of Delaware, many important facts have been omitted, and errors of calculation made, which I think ought to be pointed out and corrected, not only that justice may be done to the humble individual who claims to be the first to introduce successfully gas for lighting light-houses, generated in the building for the express purpose, but to meet all the objects of the Government in instituting this investigation.

As the originator of this light, I therefore regard it as a duty to reply to the objectionable portions of their report.

First, in page 15, paragraph 2, in comparing the relative intensity of the gas and lard lights, the board say they made use of a lard lamp, the flame of which was three inches high, whilst that of the gas was one and a half inch.

Now, in order to form a just estimate of the brilliancy of two different lights, by means of a photometer, they should be both of the same height, or the comparison cannot be made with accuracy.

Again, (page 20,) in comparing the relative intensity of gas and oil lights for light-houses, the board placed the two lights four or five feet distant from the centre of the photometer. The difference in the color of the two lights (the oil being red and the gas white) renders it impossible to form a comparison at so great a distance. In the repeated trials made by

Captain Prince, Doctor Naudain (the collector at Wilmington) and myself, by means of a photometer constructed according to the directions of Doctor Ure, the gas light was invariably three times the intensity of the oil light heretofore used at the light-house. (Vide Captain Prince's report to the Secretary of the Treasury, on the gas light at Christiana.)

In the next place, that part of the report which relates to lard as a means of obtaining light, although the great superiority of gas over oil is admitted, is calculated to mislead the department into the belief that lard can be used advantageously in light-houses. I deem it impracticable to burn lard in the focus of our light-house reflectors, in the present light-house lamps, or any other lamp now known; nor is it at all probable that a lamp can ever be constructed for the purpose, from the fact that lard requires a great heat to keep it fluid, which can only be done when the burner of the lamp is placed in the fountain. Such a lamp could not be used for light-house purposes. Again, should a lamp to burn lard for light-houses ever be invented, the obstruction that it would unavoidably interpose to the rays of light emanating from the focus of the parabolic reflectors used in light-houses would be more than our present light-house lamps, which are considered defective in that particular. To this objection the gas burner, from its diminutive size, is of course not obnoxious, and, being plated, affords a perfect remedy to that defect of the present lamps.

Again: The extreme heat of the lard lamp, indispensable to keep the lard in a fluid state, will, on every occasion that the wicks require trimming, which occurs not less than three times during the night, render the necessary handling very difficult, not to say impossible, without the lapse of sufficient time for it to cool. Nor should it be forgotten, that, during this manipulation, the light would be materially diminished, and rendered unsteady, to the great danger of the mariner, who would be liable to mistake the particular light-house by which he might be directing his course. It is true that this difficulty exists with the present oil lamps, though not to the same extent; but it is equally true that gas entirely obviates it.

In the middle and northern latitudes, it is found necessary to use not only a charcoal stove, but also a copper heater connected with the lamp, to keep winter-strained oil in a fluid state. Even with these aids, during the intense cold of three months of the year, it is frequently very difficult to keep the oil in a proper condition for use. From these facts some inference may be drawn of the inapplicability of lard to the purpose.

Again: The character of the flame of a lard lamp is not such as would recommend its use in light-houses, as the flame of lard is from three to four inches high. Of course, only one inch of that flame would be in the focus of the parabolic reflector; the remaining two-thirds would be diffused and measurably lost.

Again: The board is in error with regard to the cost of the gas light. They have based their calculations of the cost of materials upon the result of a single operation, (page 25,) which proved nothing, from the fact that the apparatus which was in proper order to make gas at 10 o'clock was not used until 12, and of course was consuming fuel for two hours to no purpose connected with the experiment. This fact the board have lost sight of, or at least have not stated in their report; but it is nevertheless true, as I was present, and vouch for its verity.

Again: The board state (p. 27) that they used 70 pounds of rosin to gen-

erate 486 cubic feet of gas. To be sure, this amount of rosin was placed in the melting kettle during the operation, but it did not come out again; and as the board did not weigh the amount of material that was in the kettle before commencing operations, and as they failed to do so when they ended, they can have no knowledge of the exact amount of rosin used. From repeated experiments of my own, and that of Captain Prince, (vide report,) together with the actual practical results since the apparatus has been in operation, a period of nine months, it has been found that from 75 to 80 pounds of rosin will invariably generate 750 cubic feet of gas. The cost of the rosin used at the light-house was 85 cents per barrel, each averaging 300 pounds.

The cost of 78 pounds of rosin would be	-	-	-	22 cents.
The cost of 3 bushels of coke, at 6¼	-	-	-	18½ "
				<hr/>
				40½ "
				<hr/>

This shows the consumption of materials for 750 cubic feet of gas. It has been proved by actual practice that 150 cubic feet of this gas will supply 5 of my burners for 12 hours, giving a light equal to 15 oil lamps now used in light-houses; and as 750 feet of gas cost 41 cents, 150 feet, sufficient for one night, would cost 8½ cents—thus showing a mistake in the report of the board of 10 cents per night in the cost of material. The report of the board makes the consumption of material 18.66 cents.

As the cost of rosin now is but 65 cents per barrel, the cost of 78 pounds would be	-	-	-	-	-	17 cts.
Three bushels of coke, at 6¼	-	-	-	-	-	18½ "
						<hr/>
Cost of 750 feet of gas, sufficient for five nights	-	-	-	-	-	35½ "
						<hr/>

The cost for one night would be 7.3 cents.

The total cost of materials for making gas one year	-	-	-	\$26 64½
Wear and tear of apparatus for one year	-	-	-	23 25
				<hr/>
Cost of gas light per annum, (five burners)	-	-	-	49 89½
				<hr/>

But a more practical and accurate estimate of the cost of the gas light can be derived from the monthly returns of the light-house keeper for the last six months; and by reference to the returns of the keeper of the same light-house for the oil light for the last five years, the relative costs of the two lights can be had.

The average consumption of the present light-house lamps is 1 pint in 12 hours; and as 15 oil lamps are required to give the same amount of light as 5 gas burners, the consumption of oil for one year would be 684 gallons, which, at \$1 per gallon, (the average price for the last five years,) would amount to	-	\$684 00
To which must be added, for tube glasses, soap, brooms, whitening, wicks, &c.	-	25 00
And for repairs of lamps, oil cans, oil houses, &c.	-	25 00
		<hr/>

Making the total cost of oil light of 15 lamps for one year 734 00

The consumption of lard in one of Cornelius's parlor lard lamps, similar to the one used by the board in their examinations, has been found, by repeated trials, to be 27 ounces in 12 hours, giving the same amount of light as one of the light-house burners.

At this rate, 5 lamps would consume, in 12 hours, 8 pounds 7 ounces, being 3,079 pounds 11 ounces per annum; which, at 6 cents per pound, the present price of lard, would be	\$184 75
The cost of wicks, tube glasses, soap, whiting, &c., would be the same as for oil	25 00
Repairs of the necessary cans, lamps, &c., per annum	25 00
	<hr/> 234 75 <hr/>

The estimate of \$23 25 for the wear and tear of the gas apparatus is based upon the experience of 9 months at the light-house at Christiana; and I have no doubt that, with the present improved apparatus, it will be still less.

Table of the relative cost of gas, lard, and oil lights.

Kind of light.	Number of lamps and burners to give same amount of light.	Consumption of materials per annum.				Cost of materials per annum.	Annual cost of wicks, brooms, soap, whiting, &c.	Annual repairs.	Total cost per annum of each light.	Relative cost of each light.	Amount saved per annum by substituting gas or lard for oil.
		Coke, in bushels.	Rosin, in barrels.	Lard, in pounds.	Oil, in gallons.						
Gas	5	219	19	-	-	\$26 64½	-	\$23 25	\$49 89½	1	\$684 11½
Lard	5	-	-	3,079.11	-	184 75	\$25 00	25 00	234 75	5½	499 25
Oil	15	-	-	-	684	684 00	25 00	25 00	734 00	15¼	

The board, in their report, (page 39,) state that it will cost \$100 per annum for the repairs of apparatus and building; also, for renewing and setting retorts, \$50 per annum; to which they add, \$15 for grate bars, &c. To the first charge, of repairs for apparatus and building, I would state that the building itself, to contain the apparatus, will not be subject to any greater expense than an ordinary building for other purposes of the same size, (16 by 16 feet;) and the only part of the apparatus that will require any increase or repair is the retort and fire bricks in the furnace, for which the preceding estimate (\$23 25) is amply sufficient.

Another charge that the board makes in their report, (page 39,) is the interest on the first cost of the gas apparatus, (which they estimate at \$1,500,) ninety dollars per annum. As they have failed to tax with interest the building of the light-house, salary of keeper, prices of necessary oil or lard, lamps, reflectors, &c., it would be but just to relieve the gas apparatus to the same extent.

The report of the board, in answer to the Fifth Auditor's question respecting the originality of the invention, states (page 49) that there is no novelty in making gas from rosin. To this I would reply, that I never preferred any claim to the discovery of rosin gas.

In the same page, in detailing the various portions of the apparatus, they particularly mention all those portions that bear any resemblance to other gas establishments, whilst those parts that are really original are not so noticed. In speaking of the vertical branch attached to the retort, (page 48,) they say that it has probably the advantage of yielding less tar than would otherwise be obtained. It is proper here to remark, that wherever there is a saving of tar, there is a proportionate *increase* of gas; and that the great advantage of my apparatus is, that, with a retort 4 feet 6 inches long, it will generate (vide report of board, page 26) 196 cubic feet of gas per hour, making only sufficient tar to return to the kettle to render the rosin fluid. This shows that the whole amount of rosin is converted into gas—a feature altogether novel, and found in no other rosin gas establishment. Some advantage must result, most obviously, from the improvements in my apparatus; for, at the Wilmington and other gas works, the time required to generate 196 feet of gas is 2 hours—twice the time required by mine—while their apparatus is nearly twice the size. They also incur a waste of at least 20 per cent. of the rosin employed to make gas, in the shape of refuse tar.

Again, (page 23,) the board state that the illuminating power of the gas had evidently increased, as the light-house burner became heated, and the consumption of the gas was the same as in their former trials, showing the advantage resulting from the use of my burner; while, in their answer as to the originality of the invention, they pass over this manifest improvement without mention.

Again: In their report, (page 49,) in reference to the feeder employed in my apparatus, (which they term a "tar seal,") they say it keeps the melted rosin very hot, and obviates choking in the supply pipe; beyond this, they say they are not aware of its being superior to the common syphon tube used in other gas works. The great desideratum for a light-house is a sure and safe light, which could not be insured with an apparatus fed by a syphon tube. As the keeper never makes gas until his gasometer is emptied, should the syphon become obstructed, he could not make gas until the obstruction had been removed, which could not be done in time to make gas for that night's supply. It is therefore important that the great and admitted defects in the use of the syphon are thoroughly obviated by my invention of the tar seal.

Again: The board have also failed to state, in their answer as to the originality of this invention, that this Christiana light-house is the *first* and *only* light-house ever successfully lighted by means of gas generated in the light-house. It has been heretofore deemed, by some of the most learned and scientific men in Europe and this country, utterly impracticable, particularly in its application to revolving lights. (Report of Allan Stevenson, commissioner of lights of England and Scotland, House of Commons, 1834.)

There are several other improvements, of which the board have made no mention, which are not necessary to enumerate.

In arriving at results in the progress of this investigation, it is important to bear in mind that every thing relating to the introduction of gas for light-house purposes has been reduced to the test of practice; embracing its

adaptation, its cost, quality, safety, regularity, &c. ; whilst lard light, for the same purpose, is entirely hypothetical, and the hypothesis, too, is sustained by calculations that are erroneous, and arguments that are unsound, as I think I have shown in a previous part of this letter.

One important fact is admitted by the board ; which is, that the kind of lamp necessary to be used for burning lard for light-house purposes is *yet to be invented* ! This makes a hiatus between their premises and conclusions, that leaves the matter both speculative and problematical. I would further remark, that the experiments of the board were entirely defective in one important point, to wit: they fail to *prove* any thing in relation to the practical adaptation of lard light for light-house purposes. The difference, therefore, between the relative recommendations of gas and lard, as they now exist, is just the difference between practice and speculation.

For the information of the honorable the Secretary of the Treasury, I would state, that since the erection of the gas apparatus at Christiana, I have made a number of important improvements in the construction of the same. The improved apparatus can be managed (and repaired if necessary) by any man of ordinary capacity, without the assistance of a second person. It also dispenses with the use of a brick furnace, is portable, and requires but half the space necessary for the present apparatus at the light-house. I would also state, that this mode of lighting light-houses is an invention of my own, and that the experimental apparatus at Christiana was erected by myself, under the sanction of the late Secretary of the Treasury, the Hon. J. C. Spencer, by whose authority a practical investigation of and report was made upon the same, by Captain Henry Prince, of the revenue marine, to which report I would refer for many important practical results not enumerated or alluded to in the report of Messrs. Johnson, Cresson, and Smith.

I claim for my invention—

1st. That it will afford the steadiest, most uniform, safe, and brilliant light that can be used in light-houses.

2d. That, supposing lard to be applicable to the purpose, (which, for the reasons I have before adduced, I do not hesitate to deny,) my apparatus will impart greater light at one fifth the cost of lard, and at one-fifteenth the cost of oil.

3d. That the difference in the cost of oil and gas will in five years defray the whole expense of erecting houses, apparatus, and fixtures, for the manufacture and introduction of gas in all the light-houses in the Union ; and that thereafter it will save to the Government about \$100,000 annually—more than sufficient to pay all the salaries of the light-house keepers.

Before closing this communication, I cannot avoid, as a friend of science, and apart from any personal interest which I might be supposed to have in the subject, expressing the gratification which the perusal of a major portion of the report of the examining board has afforded me, and which it cannot fail to impart to all who desire the diffusion of scientific knowledge and the adoption of scientific improvements. For the acknowledgment of the complete success of my invention, I am constrained to be grateful, however much I may regret their errors of calculation and the omission of important facts from their report. For the earnest testimony they bear to the superiority of gas over the material now used in our light-houses, as well on the score of brilliancy and safety as economy, and the

satisfactory manner in which they dispel the mists in which ignorance or the prejudice of habit sometimes for a period successfully envelopes every improvement on its first introduction, I can excuse the respectable gentlemen who composed the board for their failure to indicate with greater precision and clearness those portions of my apparatus which claim the merit of originality.

I should be much pleased to have this statement submitted to the Committees on Commerce in the Senate and House of Representatives, together with Captain Prince's report, when you present that of Messrs. Johnson and his associates.

Very respectfully, your obedient servant,

BENJAMIN F. COSTON, *U. S. N.*

Hon. G. M. BIBB,

Secretary of the Treasury.

COLLECTOR'S OFFICE,

Wilmington, Delaware, January 18, 1845.

SIR: In answer to your letter of the 10th instant, enclosing certain "papers touching the comparative advantages between the use of lard, or other oil, and gas, in the light-house establishment," I have the honor to submit the following remarks:

First. As to the actual cost of materials for making gas.

The gas consumed by five burners at the Christiana light-house in 196 nights, say from the first day of June to the 31st day of December, 1844, both inclusive, except 18 nights in the month of September, when the gas was suspended, and oil used, on account of being obliged to build a new chimney in the gas-house, was made from the following materials, viz: Fourteen and a half barrels of rosin, at 85 cents per barrel, amounting to \$12 32½; 118 bushels of coke, at 6¼ cents per bushel, \$7 37½; 1½ ton anthracite coal, worth \$5 55; 1 bushel of fire clay, cost 50 cents; 1½ cord of wood, cost \$7 50—amounting in the whole to \$33 25; which sum, divided by 196 nights, gives 16.96 cents as the cost per night, for materials used, or \$61.904 per annum.

Admitting, then, that the average consumption of gas at the Christiana light-house is about 160 feet for five burners per night, which is believed to be very near the quantity consumed, it follows that 31,360 feet of gas has been produced from 14½ barrels of rosin, which, if estimated at 300 lbs. per barrel, would be 4,350 pounds of rosin. It is proper to say, however, that the *weight* of rosin consumed is not known, and the keeper informs me that there were some small barrels, and some of the others were not full.

Second. As to the cost of lard.

Less than five burners, whether of gas or lard, would be insufficient for the light-house at Christiana; and the value of the lard necessary to maintain five burners one year would be, according to the estimate of the committee of examination, \$171 87.

Third. As to the cost of oil.

Before the introduction of gas into the Christiana light-house, there were eight lamps used, (and this is the least number of oil lamps that would be

sufficient,) which consumed, during the year 1843, 344 gallons of oil, which, at 91 cents per gallon, the average cost of oil during the present year, would amount to \$313 04; and yet, for all practical effect, the amount of light produced by the gas is at least double of that produced by the eight oil lamps, although the expense of the materials consumed bears so small a proportion to the cost of the oil.

The above statements, as to the cost of the materials for gas, and the consumption of oil, are taken from the returns of the keeper of the light-house, and are believed to be correct.

Fourth. As to the fitness of gas for light-houses.

I entirely agree with the committee in all they say as to the fitness of gas for light-house purposes; its safety from danger of explosions; its suitableness for fixed or revolving lights, or for reflectors or lenses; and its burning freely in any known natural temperature.

Fifth. Relative advantages.

Inasmuch as lard cannot be introduced into our light-house establishment, for want of a suitable lamp to burn it in the focus of the reflectors used in our light-houses, and as it is problematical whether such a lamp can be invented, I shall not pursue the comparison between lard and gas as a means of lighting light-houses; although gas, it must be apparent, would have many advantages over lard, even if there were no mechanical difficulties in the way of its use.

From the results obtained with our experimental apparatus at Christiana, it is apparent, that lighting up light-houses with gas will be much cheaper than with oil, unless the apparatus shall be too costly in its original structure, or too expensive to keep in repair.

It is believed that the gas-house and all the apparatus for generating gas may be erected, except in unfavorable situations, for from twelve to fifteen hundred dollars. From the materials and structure of the apparatus, no other parts appear liable to get out of order, or to involve much expense of repair, except it be the furnace, retort, grate bars, and shield for retort. These would probably have to be renewed annually, and not oftener, and would cost at our foundries about the following prices: Retort, \$17; grate bars, \$3; cast iron shield for retort, (in place of soapstone, now used,) \$8; fire brick, \$9; setting new retort, \$4—amounting, for repairs of furnace, retort, &c., to \$41.

The gas-house, if well built, would require so little to keep it in repair, that it would scarcely be necessary to make an estimate for it. This, added to the cost of materials for making gas, would make \$102 90 per annum, or about 28.2 cents per night. I have said nothing about the interest on the original cost of the gas-house and apparatus.

The expense of oil for Christiana light-house in 1843, as before stated, at 91 cents per gallon, was - - - \$313 04
Add for wicks, tube glasses, and repairs of lamps - - - 13 00

Making for the year - - - - - 326 04
or about 89.3 cents per night, or 3.166 times as much as gas.

I would observe that Mr. Coston has shown me the model of an improved furnace and condenser, which I think will be at least equally effective as those now in use, while it is more simple, less costly, and more

easily repaired, and I think its introduction into our light-house at Christiana would materially lessen the annual cost of repairs.

In the foregoing observations as to the comparative advantages of lighting the light-house establishment with gas, or lard, or other oil, I have only presented data which I think may have an important bearing upon the subject; and these are drawn from the experience derived from seven or eight months' use of an experimental gas apparatus, which I believe may be improved, and the actual consumption of oil at the same light-house during the year 1843.

The papers received with your letter are herewith returned.

I have the honor to be, most respectfully, your obedient servant,

ARNOLD NAUDAIN, *Collector.*

HON. GEORGE M. BIBB,

Secretary of the Treasury.

Report on the gas-light apparatus invented and erected by Benjamin F. Coston, now used at the light-house at the mouth of Christiana river, in the State of Delaware, by a committee appointed for that purpose.

SUPERINTENDENT'S OFFICE,

Wilmington, Del., December 19, 1844.

SIR: I have the honor to transmit the report of Messrs. Walter R. Johnson, John C. Cresson, and George W. Smith, on the gas-light apparatus used at the light-house at the mouth of the Christiana river, made in pursuance of your letter dated the 30th of October, 1844.

It appears to me that many important facts on the subject of generating light are brought forward in this report, which may be turned to great advantage in the light-house establishment of the United States. The great desideratum, however, to profit by the most important fact elicited, viz: the superior cheapness and efficiency of lard in the production of light, seems to be to secure the construction of a lamp which will burn lard in the focus of our reflectors. This cannot be done with our present light-house lamps. The lard could not be kept in a state to flow into the burner. I have no doubt, however, that this difficulty can be obviated by an ingenious lamp maker, and, should it meet your approval, I will endeavor, with as little expense as possible, to have such a lamp constructed.

The whole expense necessary for the introduction of lard in our light-houses would be new lamps, which, when a proper pattern was made, could not exceed \$4 to \$5 each—an inconsiderable sum, when compared with the saving of two-thirds of the expense of the oil now consumed.

I have the honor to be, most respectfully, your obedient servant,

ARNOLD NAUDAIN, *Superintendent.*

STEPHEN PLEASANTON, Esq.,

Fifth Auditor, &c.

Letter from Arnold Naudain, Esq., collector and superintendent of light-houses at Wilmington, Delaware, to Walter R. Johnson, John C. Cresson, and George W. Smith.

COLLECTOR'S OFFICE,
Wilmington, November 15, 1844.

GENTLEMEN: I have been directed by Mr. Pleasonton, the general superintendent of the light-houses in the United States, to cause the Christiana light-house, which has been fitted up for the use of gas, to be inspected by three scientific and disinterested persons, for the purpose of reporting upon the fitness of gas for light-houses, &c.

I would therefore respectfully invite you to inspect the said light-house, and the gas apparatus attached thereto, and to report thereon, in conformity to the instructions of Mr. Pleasonton, contained in his letter dated 30th ultimo, a copy of which I have the honor to enclose.

I am, gentlemen, most respectfully, your obedient servant,

ARNOLD NAUDAIN, *Collector, &c.*

Messrs. W. R. JOHNSON, JOHN C. CRESSON, and GEORGE W. SMITH.

REPORT, &c.

PHILADELPHIA, December 16, 1844.

SIR: Your letter to us of the 15th November, 1844, has been duly received, accompanied by one from the general superintendent of light-houses in the United States, of which the following is a copy:

"TREASURY DEPARTMENT,
"Fifth Auditor's Office, October 30, 1844.

"SIR: I intended, as I informed you some time ago, to have joined you about this period in the inspection of the gas light at the mouth of the Christiana river, but now find it out of my power. As it will be necessary to make a report to Congress in relation to this light at the next session, I am desirous of having it examined by three scientific and disinterested men, and a report made by them as to its fitness for light-houses, its advantages and disadvantages, and its economy or otherwise, in relation to other kinds of lights, and as to whether the mode of generating the gas is an improvement, or is made upon the principle generally adopted. If an improvement, to state in what it consists.

"You will be pleased to select three such gentlemen, either in Wilmington, Philadelphia, or Baltimore, and invite them to inspect the works at Christiana, and report to you their joint opinion on the several points indicated above, and particularly whether, from the explosive nature of gas, it would be advisable to adopt that mode of lighting our light-houses, with keepers ignorant of nearly all the properties of gas.

"You will pay the expenses of these gentlemen, it being presumed that they will charge nothing for their services. You will be pleased to give Mr. Coston, the author of these works, notice of the time these gentlemen may appoint to enter upon this investigation.

"I have the honor to be, respectfully, sir, your obedient servant,

"S. PLEASONTON.

"ARNOLD NAUDAIN, Esq.,

"Superintendent of Lights, Wilmington, Del."

In compliance with your invitation, and in conformity with the above letters, we have visited the light-house near Wilmington, and, together with Mr. Joseph Cresson, who obligingly volunteered to aid us with his practical experience in making observations and experiments, have applied the necessary means to decide the several questions submitted for investigation.

As, in matters of practical science and the useful arts, little reliance is at the present day placed on mere opinions, unless sustained by facts well authenticated, observations which can be repeated, and experimental results which can be reproduced, we felt assured that rigorous methods of trial could alone be of much service to the department which sought the information.

To aid in conducting these trials, a portable gas metre, from the Philadelphia gas works, together with the necessary attachments, some burners for comparative trials, a syphon gauge to ascertain the pressure under which the gas flowed, and a suitable receptacle for bringing a quantity of the gas to Philadelphia, were provided by Professor Cresson. A reflecting photometer, on the plan of Dr. Ritchie, was kindly loaned to the committee by Professor Frazer, of the University of Pennsylvania. A fine solar lard lamp, to serve as a standard, was obligingly prepared, at our request, by Messrs. Cornelius & Co. Other necessary instruments were procured by different members of the committee, which, together with the necessary weighing apparatus that you were able to procure in Wilmington, afforded the means of proving experimentally all the points which we considered important in order to answer Mr. Pleasonton's inquiries. In all our examinations at the light-house, we had the advantage of the attendance of Mr. Coston, under whose direction and superintendence the gas apparatus was constructed.

The principal parts of that apparatus, are—

1st. A copper *receptacle* of a cylindrical form, for melting the rosin out of which the gas is generated. To this is attached, near the bottom, a tube, furnished with a stopcock, to regulate the flow of rosin according to the demands of the process.

2d. A *retort*, of cast iron, four feet long and ten inches interior diameter, lying in the furnace in the usual horizontal position. The mouth of the retort projects about three inches in front of the brick work* in which it is set. At fourteen inches from the front of the retort, and consequently within the furnace, is a vertical tube, three inches in diameter, through which flows the melted rosin by a tube of much smaller diameter, and which opens into the upper part of an air-tight box. Into this box, near the bottom, opens another tube, which passes through the lid, and has at its upper extremity a funnel to receive the melted rosin coming from the receptacle already described. The air-tight box serves as a seal, and in place of the syphon elsewhere employed for similar purposes. When in use, the retort is filled with coke, of which it holds about one and a half bushel.

3d. The *condenser* consists of a cast-iron neck, connected by a flange, and bolts to the rear end of the retort; a tar chest, four feet long and twelve inches square outside, and six iron tubes, three inches in diameter and ten

* In the New York rosin gas works, the retorts are set in a furnace, the outer casing of which is of cast iron. This may probably be, on the whole, an economical arrangement.

feet high, rising from the top of the chest, connected two and two at top, with suitable partitions descending into the tar, to cause the gas to traverse all the tubes. The neck of the retort is surrounded by a copper jacket, to contain cold water, which it receives from the lower part of the water cistern of the gasometer, by a tube entering near the bottom of the jacket, and which it discharges by another tube, passing from its upper part to near the top of the same cistern.

4th. The *tar well*, which receives the condensed tar from the chest above described, and from which it is pumped by hand into buckets, to be returned to the receptacle for melting rosin.

This tar well is made of brick; and having been constructed in cold weather, and used without full time to become dry, allows a slight leakage of tar, which finds its way into the cellar. This inconvenience might have been avoided, and may now be remedied at a trifling expense, by using in place of it a cast-iron bath tub, or other light receptacle of the same material, capable of holding two or three barrels.

5th. The *gasometer and its cistern*. The former is a sheet-iron cylinder of the usual form, open at bottom and closed at top, ten feet in diameter, and the same in height, containing seven hundred and eighty cubic feet; the latter is a wooden vat or tub, of somewhat larger dimensions, containing the water into which the former descends. A three-inch tube, coming from the upper part of the tar chest, and thence descending below the floor of the gas-house, enters the bottom of the cistern, (which also descends below the floor,) and thence rises to and opens above the top of the water in the cistern, and of course within the gasometer, to which this tube conveys the gas from the condenser. Any tar condensing in this tube finds an exit from its lowest part by a syphon placed there for its discharge. The *weight* of the gasometer (1,400 lbs.) is counterpoised by a cast-iron *counterweight*, attached to it by two chains passing over pulleys, and is thus made capable, by an increase or diminution of the latter, of dilating or compressing the gas to any required degree. The cistern is supplied with rain water from the roof; any excess being carried off by a tube, or regulating spout, placed at the required level. The vertical motion of the gasometer is insured by an iron rod descending from the ceiling of the gas-house to the bottom of the cistern, passing through a tube three inches in diameter, fitted centrally to the top of the gasometer, and descending to the level of its lower edge, with braces to maintain its position.

6th. The *conducting tube and burners*. The gas is conveyed from the gasometer by a tube one inch in diameter, first horizontally about thirty-five feet, and then vertically to the height of about forty feet above the level at which it leaves the gasometer. At the level of the deck of the lantern is a mercurial seal, from which rises that part of the vertical tube which receives the five horizontal arms conveying gas to the burners. Its upper end is supported by a ring, in which it turns freely, allowing the arms to be placed in any desired direction. The burners are constructed on the argand principle, each containing twenty holes or jets, in a ring of one and one-eighth inch in diameter. The support of the glass tube which surrounds the flame of each burner is furnished with a cone somewhat on the solar principle, but not rising higher than the ring which contains the jets. The centre of each flame is nearly in the focus of a parabolic mirror, of plated copper, fourteen inches in diameter. The addition of the usual machinery and moving power would readily convert this into

a revolving light. From the foregoing description, it will be seen that every part of this apparatus is very simple and intelligible.

Having, on the 21st November, inspected the apparatus, gas-house, and lantern, we proceeded to examine the quality of the gas remaining in the gasometer. For this purpose, a branch pipe, which leads to the dwelling part of the premises, was employed. Having detached the burner, we connected with this pipe the experimental metre above mentioned, and, allowing the gas to flow, attached the syphon gauge, which showed that the gas was under a compression equivalent to four-tenths of an inch of water, the counterweights of the gasometer remaining in the same condition as on the preceding night.

We next attached to the exit tube of the metre a double-coned argand gas burner, with fourteen jets or holes, around a ring thirteen-sixteenths of an inch in diameter; which being lighted, the metre was observed for ten minutes, and found to be delivering gas at the rate of 2.25 cubic feet per hour—the thermometer standing at 63° . The lard standard lamp, which had been previously prepared and lighted, and its flame duly regulated to the height of three inches, was now compared with the gas flame, by placing the reflecting photometer immediately between them. By carefully adjusting the distances of the two flames, so as to make as usual the reflected light from each equally bright, the centre of the photometer was found to be distant from the centre of the lard flame 68.9 inches, and from that of the gas flame 41.25 inches. Hence the gas flame is at present represented in intensity by 1701.52, and the lard flame by 4747.21, or the standard lard is to the gas flame as 1 to 0.3584; so that the lard light is 2.79 times as powerful as the gas.

2. Having attached one of Mr. Coston's light-house burners above described, we allowed the gas to flow without altering the stopcock which regulated the supply of gas in the preceding experiment. Again observed the flow of gas through the metre, and found it to be 2.17 cubic feet per hour—temperature 66° . Measured the distances from centre of photometer, as follows:

	Inches.
To centre of standard solar lard flame	68.1
To that of Mr. Coston's argand gas flame	41.3

Hence the intensities are as 4637.61 to 1705.69, or as 1 to 0.3678; and the lard light is 2.71 times as powerful as the gas.

3. Tried the above experiment again, after the gas burner had become heated to the boiling point of water. Then the distances were—

	Inches.
To lard flame	67.75
To gas flame	41.3 as before.

The intensities were, therefore, as 4590.06 to 1705.69, or as 1 to 0.3716; and the lard light was 2.69 times as powerful as the gas light. Immediately after completing this observation, the gas was found to be passing the metre at the rate of 2.16 cubic feet per hour.

4. Having cleaned the glass tube, or chimney of the gas flame, the lights were again compared:

	Inches.
Distance from standard lard flame	67.0
Distance from gas flame	42.12

The illuminating powers are consequently as 4489.00 to 1774.09, or as 1 to 0.3952; so that the lard light is 2.53 times as powerful as the gas light. The gas came through the metre, by a mean of ten sets of observations, taken immediately after this comparison, at the rate of 2.375 cubic feet per hour—temperature 72°. The slight discrepancies in the rates of flow in the several trials may be accounted for by the friction of the pulleys over which the supporting chains of the gasometer pass, being liable to some inequalities, especially at the very moderate preponderance which the gasometer had over its counterweight. It appears that the gas gained gradually upon the lard in intensity—

The latter being by the	<i>first</i> trial,	2.79	times as strong as the gas.
Do	do	<i>second</i> trial,	2.71 do do.
Do	do	<i>third</i> trial,	2.69 do do.
Do	do	<i>fourth</i> trial,	2.53 do do.

And the mean being 2.68

5. Immediately after the preceding trial and observation in the rate of flow, the gas flame remaining unaltered, we made a comparison between it and one of the lamps which had been used in the lantern of the light-house previously to the introduction of gas. It had been trimmed and prepared, and its flame adjusted by the keeper, to correspond as nearly as possible with his usual practice. The distances from the centre of the photometer were now as follows:

	Inches.
To the centre of oil flame - - - - -	49.9
To that of gas flame - - - - -	56.3

Or the oil is to the gas as 2490.01 to 3169.69; and the oil flame is therefore only 0.785 as powerful as the gas flame.

By a comparison between the two preceding experiments, and using the gas flame as a standard between oil and lard, the former burned as in the light-house, and the latter with a standard flame three inches in length, they are found to stand thus—lard, 2.53; gas, 1; oil, 0.785; showing that between the lard flame and the oil flame, thus used, the relative illuminating powers are as 3.223 to 1—making the lard light unity, the oil light is 0.3103.

In all the experiments thus far, the gas had been burned more slowly than in the lantern of the light-house, the flame being constantly less than two inches in length.

6. Now admitted more gas to pass, producing a flame exactly two inches high. Observed the metre for ten minutes, and found it to be delivering 2.69 cubic feet of gas per hour. Compared the light with that of the lard standard:

	Inches.
Distance of lard standard - - - - -	61.5
Distance of light-house gas flame - - - - -	51.1

The intensities are therefore 3782.25 and 2611.21; showing that the lard light is now to the gas light as 1 to 0.6904, or as 1.448 to 1.

7. Keeping the regulating stopcock of the gas pipe exactly as in the last experiment, the oil lamp, regulated as before, was now brought directly into comparison with the gas as burned in the light-house. The result was:

	Inches.
That the distance from centre of gas flame to photometer was	55.3
That from the oil flame	39.0

And the relative powers of the lights were 3058.09 and 1521.00, or gas light is to oil light as 1 to 0.4973. This trial, with the one immediately preceding, offered another comparison between the lard and the oil lights.

Thus—lard, 1.448; gas, 1; oil, .4973; gives the lard to the oil as 2.911 to 1; or, making the lard light unity, the oil light is 0.3435.

Immediately after the above photometrical observations had been completed, the metre was again observed for ten minutes, and the rate of flow found to be 2.725 cubic feet per hour. Hence the two sets of observations taken since adjusting the gas light to that of one of the burners in the lan-

tern, give $\frac{2.69 + 2.725}{2} = 2.707$ cubic feet per burner per hour. At this rate, the five burners in the lantern will consume in twelve hours 162.42 cubic feet.

After the above experiments had been completed, a portion of the gas was used for the light-house before making our next trials, which took place on the day following, (November 22.)

To test the actual consumption of lard by the solar standard lamp, and of oil by the argand lamp of the light-house already tried, they were this morning filled to the usual height, properly trimmed, and weighed. The lard lamp burned from 10 hours 9 minutes A. M., till 5 hours P. M.; consumed 6,503 grains, or .929 of a pound, in 6.85 hours, being at the rate of .1356 of a pound per hour.

The oil lamp was burned from 11 hours 42 minutes A. M., to 5 hours P. M., or 5.3 hours, during which it consumed 2,576 grains, or .368 of a pound, being at the rate of .069943 of a pound per hour; and, as oil weighs 7.6 pounds per gallon, this gives .009267 of a *gallon* per hour; and for 8 lamps, 12 hours, .889632 of a gallon, which is 324.7 gallons per annum.

By an examination of the books kept at the light-house, and containing a registry of the quantity of oil actually consumed while 8 oil lamps were employed, we found that, for the year 1843, it was—

In the first quarter, 109 gallons;

In the second quarter, 76 “

In the third quarter, 67 “

In the fourth quarter, 72 “

And hence the total for the year was, 324; which is within a fraction of a gallon of what our experiment and computation make it. It is true that a small portion of the oil supplied in that year was burned in hand lamps, lanterns, &c., for the use of the keeper; but this cannot materially affect the general result, which proves that the lamp which we weighed was trimmed and burned with a remarkable conformity to the general practice. It probably consumed more oil, and gave more light, than its average in the lantern. We have assumed 12 hours to be the average length of a light-house night, because the lamps are always lighted at sunset and extinguished at sunrise.

8. About 20 minutes after lighting the lard lamp, a comparison was

made between its light and that of the gas as burned in Mr. Coston's apparatus. The distances were—

	Inches.
From the <i>lard</i> to centre of photometer	67.5
From the <i>gas</i> to centre of photometer	47.1

The relative amounts of light are, therefore, from *lard* 4556.2, and from *gas* 2218.4, or they are to each other as 2.053 to 1. The quantity of gas passing the metre during this trial was 2.64 cubic feet per hour.

9. In the preceding experiment, the gas flame did not appear to be quite two inches in height. The regulator cock was therefore opened a little more, to give it the standard height. The distances were then—

From *lard*—flame, 65.8 inches; power, 4329.6.

From *gas*—flame, 48.6 inches; power, 2362.

Hence the *lard* light is to the *gas* light as 1.833 to 1. Though immediately after this set of observations the metre indicated only 2.43 cubic feet of gas per hour, yet the relative illuminating power of the gas had evidently increased. The cause of this may probably be attributed to the gradual heating up of the burner, which had now attained a temperature of more than 212° . The same relative increase of power on the part of the gas had been observed on the previous day's trials. From the mean result of the two trials this day, it appears that the *lard* light was to the *gas* light as 1.943 to 1.

Immediately after the completion of the preceding experiment, the gas metre was detached, and about two gallons of the gas collected in a bottle filled with and inverted over water; the vessel corked under water, and sealed as soon as filled, to be taken to Philadelphia. When subsequently examined on the 28th November, this gas was found to have a specific gravity of .8093. As it is known that rosin gas generally varies in specific gravity from .75 to .85, it appears that the gas manufactured by the keeper of the Christiana light-house was, on the last night on which it was used, of fair medium quality, about 43 per cent. superior in density to ordinary coal gas, and, according to one mode of determining the illuminating powers of gases, ought to have about the same superiority in this respect over that material.

A portion of it, burned after the specific gravity had been ascertained, gave a flame of great cleanliness and brilliancy.

After completing the comparison of lights, and collecting the sample of gas, we again proceeded to the gas-house, to observe the process of generating gas, the quantity of materials employed, the rate at which the gasometer was filled, and other circumstances of the operation. Some gas still remained in the gasometer, its upper edge being 23 inches above the top of the cistern. The fire under the retort had been lighted before our arrival, and had occupied, as stated by the keeper, about 4 hours in bringing it to a temperature of cherry redness, fit for receiving the supply of rosin. We found the latter already melted, and within about two inches of the top of the screen or strainer, which is placed in the receptacle, to prevent impurities from entering the supply tube. At 12 o'clock M., the operation was commenced, by turning the stopcock, and allowing the rosin to flow into the funnel, descend thence into the seal already described, and thus pass into the retort. In the early part of the process, the gas came over rapidly. The gasometer rose 11 inches in 22 minutes, showing the pro-

duction to be at the rate of 196 cubic feet per hour. Arrangements had been made to collect separately all the tar which should be produced this day, and not to allow it to mix with that already in the tar well. In the early stages of the process, the tar flowed freely; and portions of it were from time to time measured and returned as usual to the receptacle for melted rosin, and aiding to dissolve the fresh portions of that material, to pass again into the retort.

The operation was continued from the time above mentioned, in the manner indicated in the following schedule, without interruption or difficulty of any description, and until the gasometer was filled to its usual height, when the further supply of rosin was cut off. From this tabular view, it will be perceived that 486 cubic feet of gas resulted from the consumption of 70 pounds of rosin, and that no other material than the tar derived from its distillation was added; and this is in fact no *addition*, but only a returning repeatedly, to the retort, of those portions which escape decomposition the first time they are admitted.

Tabular view of the operation of generating gas, November 22, 1844.

Hour of observation.	Pounds of rosin supplied to receptacle up to the time of each observation.	Quarts of tar distilled over, and returned to receptacle.	Inches rise of gasometer, from commencement of observations.	Cubic feet of gas generated, from commencement to the time of observation.	Rate at which gas is generated, in cubic feet per hour.	Remarks.
P. M.						
h. m.						
0 00	0	0	0	0.00	0.00	Commenced supplying rosin to the retort.
0 22	0	0	11.	72.00	196.35	
0 45	16	0	18.5	121.09	128.05	
0 47	22	4	-	-	-	First gallon of tar supplied to the receptacle.
1 00	-	-	24.0	157.09	144.00	Weighed a bucket full of the rosin, (pulverized,) as taken from the barrel, and found it 16 lbs.
1 03	38	8				
2 00	54	12	44 $\frac{1}{2}$	292.05	134.96	
2 02	-	16				
2 28	-	20				
2 32	58					
2 45	66	24				
3 00	-	-	64 13-16	424.17	132.12	
3 07	70	30	-	-	-	A quart of tar weighed when warm 2 lbs. 2 $\frac{1}{2}$ ounces. Its specific gravity was 1.153, when at 66°.
3 25	-	36	-	-	-	All the tar hitherto produced has now been returned to the receptacle for melting rosin.
3 34	-	-	71 9-16	468.35	73.96	Ceased supplying rosin to the retort, which henceforth acts only on the materials already admitted.
4 10	-	-	74 5-16	486.35	30.00	

The heat required to raise temperature and to generate the gas was furnished by burning 2 $\frac{1}{2}$ bushels of coke, (including 1 $\frac{1}{2}$ bushel which had filled the retort in the preceding operation,) and about $\frac{1}{12}$ of a cord of wood of inferior quality. A very slight oozing of tar from one of the flanges con-

necting the retort with the tar chest was the only indication of any want of accuracy in the junctures of the apparatus; and this did not in the least interfere with its success. While producing gas, the counterweights of the gasometer were made heavier than the gasometer itself, tending thereby to raise the latter out of the water, and rather to draw the gas from the retort, to aid its passage through the tar chest and condenser, than to compel it to force its way into the gasometer against a pressure above that of the atmosphere. This prevents the escape of gas into the house.

As soon as the process was completed, we took occasion to observe the quality of the gas just produced, and judged it superior in brilliancy to that on which our first trials had been made. This might be expected, from the well-known fact, that, by remaining for some time over water, gas will deposite those vapors of the liquid hydro-carbons which give it at first a brilliancy beyond that which it displays when perfectly deprived of such vapors.

From the experiments and observations which we were enabled to make, we consider that the gas tried in our first day's operations was of a medium quality between the fresh gas just made and that tried this day, before filling the gasometer.

On two successive evenings we saw the lantern lighted up in the regular manner, noticed the height of the flames, as compared with that employed in our experiments, and observed from different distances the great brilliancy which it presented; and though we could not in this manner compare the present appearance of the light-house with that which it exhibited when oil was used, yet the experiments we have detailed afford a more accurate criterion of the relative illuminating powers of the respective materials than could be derived from casual observations, even had two light-houses been for such a purpose placed side by side.

Having now stated all the observations and experiments which our time, necessarily limited by other engagements, enabled us to make, we will proceed to a consideration of the several inquiries raised by Mr. Pleasonton.

1. *The fitness of gas for light-houses.*

On this point we do not entertain the smallest doubt, either as it regards gas in general, or the particular kind of gas produced by the apparatus at the Christiana light-house. The latter, as we have shown, has a density and illuminating power much superior to that derived from coal alone, which is used in many of our large cities.

The same reasons which in the latter situations recommend gas for the multifarious purposes requiring fixed and invariable lights, are even more cogent in the case of light-houses.

The steadiness, brilliancy, and extensive range of the light; the absence of all demands upon the attention of the keeper, after the gas has been lighted for the night, and its flow duly regulated; the easy adaptation of it to revolving lights, where such are required; the small obstruction which the burner itself opposes to the rays of light reflected from parabolic mirrors, where, as in most of our light-houses, the catoptric principle is applied; the perfect facility of combining its use with lenses, where the dioptric or lenticular light is employed; its comparative freedom from smoke, and from a tendency to soil glasses and reflectors, thus saving the rapid deterioration of the latter; its exemption from the use of wicks, and

from their multiplied annoyances, (to say nothing of their expense,) all indicate its fitness for the purposes of the light-house.

2. *Its advantages and disadvantages.*

Its *advantages* are to be found, mainly, in the circumstances just stated, together with its equal applicability at all seasons of the year, not requiring, as in the case of oil, a different article in winter from that which may be used in summer. The materials for making gas are of a nature to remain in store a long time without undergoing deterioration; whereas both oil and lard become less valuable if kept a great length of time, unless preserved in vessels hermetically sealed. The burners of gas are easily managed and regulated. The degree of luminousness of the flame of rosin gas is very constant after the burner has come to a stationary temperature. The quality of the gas itself is not so liable to vary as is that of gas produced from coal, and it requires no purification.

The principal *disadvantage* of using gas in light-houses, where the latter are so situated as not to receive their gas from some extensive gas works, is the expensiveness of the apparatus for producing it. The apparatus, however, which has been put up at the Christiana light-house, being the first erected for this particular purpose in this country, and subjected to several alterations in bringing it to perfection, is not to be taken as a criterion of the cost of future establishments of the same size. A little more intelligence and skill is required in the keeper who manages gas than in him who has only to take care of ordinary oil lamps. The mechanical skill, however, demanded for this service is by no means so great as what is represented to be requisite to manage and keep in order the mechanical or carcel lamps used in the light-houses at Neversink, where the French lenses are employed.*

The fact is worthy of notice, that the present keeper of the Christiana light, Mr. Crozier, had not the advantage of any practical acquaintance with gas previous to its introduction into the house under his care; and we have understood that, prior to taking charge of that establishment, his employment had been that of a shoemaker. A disadvantage attendant on the use of gas in very cold climates arises from the danger of freezing the water of the cistern containing the gasometer. This might in many places be obviated by filling the cistern with the purest portions of the tar produced from the operations of the works, which we have found abundantly fluid at 10° Fahrenheit, and which probably would be found so several degrees lower.

3. *The economy of gas light, as compared with other kinds of light.*

With respect to this, we would state that something will depend on the situation of the light-house to be supplied with respect to the sources of supply of the several materials. If a light-house were required at Cincinnati, Louisville, or St. Louis, and the question lay between lard, oil, and rosin, we ought to expect the relation to be more in favor of lard than at any point on the Atlantic coast; if at Nantucket or New Bedford, the relative advantage of oil would naturally be greater than at Philadelphia

* The two light-houses at Neversink could both be supplied from the same gasometer. *Bude burners* would increase the efficiency of the gas; the mechanical difficulties so much objected to in the carcel lamps be avoided, and the burner be kept invariably in the focus of the lenses.

or at New Orleans, and much more would it be greater than at Cincinnati. In any part of the coast of North Carolina, rosin ought to be expected to possess a higher relative advantage than at any point remote from that great source of supply. But the actual market is the true criterion, so far as the price of the materials determines the cost of light. To this, therefore, we resort in the present instance.

Having consulted the prices current of Boston, New York, Philadelphia, Norfolk, Charleston, New Orleans, and Cincinnati, for the day following that of our experiments, (viz : November 23, 1844,) we have been enabled to furnish the following table of prices of the three materials of which we have compared the illuminating powers:

Prices of oil, lard, and rosin, in the principal markets for those articles in the United States, November 23, 1844.

Market at which the price is given.	Authority furnishing the prices.	LARD. Price, in cts per pound.	OIL. Price, in cents per gallon.			ROSIN. Price, in cents per barrel of 300 lbs.
			Winter strained.	Spring and fall strained.	Summer strained.	
Boston -	Boston Shipping List -	6 a 6½	100 a 102	95 a 97	-	75 a 85
New York -	New York Commercial and Shipping List -	5¾ a 6½	100 a -	95 a 97	95 a 97	58* a 70
Philadelphia	Philadelphia Commercial List and Price Current -	5 a 6½	105 a 110	100 a 105	-	60* a 75
Norfolk -	Norfolk Beacon -	-	100 a 110	-	70 a -	60 a 65
Charleston -	Southern Patriot and Charleston Courier -	6¾ a 7	100 a 105	85 a 95	-	62 a 75
New Orleans	New Orleans Price Current -	5½ a 6½	105 a 110	100 a 105	95 a 100	80 a 100
Cincinnati -	Peabody's Price Current and Daily Chronicle -	4¾ a 5	125 a -	-	-	150 a 200

The lard used for burning in lamps is generally inferior to that employed for culinary purposes, and is called "No. 2" in the Cincinnati market. Assuming that by purchasing on contracts large quantities of these several articles, for cash, the Government would obtain them at prices, respectively, proportionate to the minimum rates here quoted, we find that for the Atlantic seaboard and the Gulf of Mexico the relative prices will, on an average of five markets, for *lard*, be 5.8 cents per pound; of six markets, for *winter oil*, be 101.6 cents per gallon; of five markets, for *spring and fall oil*, 97.0 cents per gallon; of three markets, for *summer oil*, 86.6 cents per gallon; of six markets, for *rosin*, 65.8 cents per barrel.

We have been informed, by Mr. Coston, that the rosin used at the light-house cost 85 cents per barrel; and by the general superintendent of light-houses, in a communication hereto annexed, that the contracts for oil for the present year have been in the spring at the prices following:

* The price of rosin per barrel, in New York and Philadelphia, is *supposed* to refer to barrels of 250 pounds; the papers do not, however, discriminate in this particular. We have heard of 300-pound barrels being sold as low as the mean minimum of the Atlantic markets since the date to which these prices refer. This day (December 16) 650 barrels, of 300 pounds each, have been sold at 65 cents per barrel, delivered on the wharf above Kensington.

For spring oil, 78 cents per gallon; for winter oil, 85 cents per gallon.

In the autumn it has been—

For spring oil, 90 cents; for winter oil, 93 cents.

The contracts for our light-houses require that two-thirds shall be summer and one-third winter oil. Two gallons of summer oil, at 86.6 cents per gallon, with one of winter oil, at 101.6 cents, will form a mixture worth 91.6 cents per gallon; and two gallons of spring oil, at 90 cents, with one of winter, at 93 cents, as actually paid during the past autumn, make the average cost 91 cents. In 1841, the average cost of oil was 93.2 cents per gallon.* Our calculations of relative economy will therefore be based for the Atlantic on the minimum market prices, viz :

Lard, 5.8 cents per pound; oil, 91.6 cents per gallon; rosin, 65.8 cents per barrel.

For the Lake country we may assume the Cincinnati prices, viz :

Lard, 4.75 cents per pound; oil, \$1 25 per gallon; rosin \$1 50 per barrel.

The gas coke used at the Christiana light-house costs 6½ cents per bushel, and the wood we assume to cost \$3 per cord.

As we have seen 486 cubic feet of gas made from seventy pounds of rosin, with 2½ bushels of coke and one-twelfth of a cord of wood, and as we have found 162.4 cubic feet of gas sufficient to serve the 5 burners an average night of 12 hours, it appears that the materials for making gas for one night will cost 18.66 cents, of which the rosin alone costs 5.1296 cents. The interest on the cost of the gas apparatus and gas-house (estimated at \$1,500) is, for one day, 24.6 cents. The annual repairs of building and apparatus, except retort, we estimate at \$100, or 27.5 cents per night.

From the experience of other establishments using rosin gas, we estimate that the renewal and resetting of retorts alone will cost \$50 per annum, or 13.7 cents per night; and other repairs, such as grate bars and soapstone, for defending the retort, \$15 per annum, or 4.11 cents per night. As the reflectors will cost the same, whatever species of light is used, and the gas burners and glass tubes or chimneys will cost about the same probably as the lamps and corresponding appendages for lard or for oil,† the five items just given may be taken to constitute the nightly expense of gas, viz : 88.47 cents.

The comparison of lights in the 6th and 7th experiments above given, when the gas was of medium quality, proved that 5 gas burners are equal $5.4973 = 10.01$ oil lamps. Hence, to furnish the *same quantity of light* from oil which is now given by the gas, will take $10.01 \times .009267 \times 12 = 1.113$ gallons of oil, which, at 91.6 cents per gallon, will cost 101.95 cents.

By the same comparative experiments, the number of lard lamps equal in power to 5 gas burners is $\frac{5}{1.448} = 3.45$. Each of these burning .1356 of a pound of lard per hour, the whole would in 12 hours consume 5.602 pounds, which, at 5.8 cents per pound, will cost 32.49 cents per night for the light-house.

Hence we have for a given amount of light on the Atlantic and Gulf of Mexico the following comparative table of the expenses of the several materials :

* See report of Committee on Commerce, 1842, pages 40, 41.

† Glass tubes for oil and lard lamps are broken in *handling*; those for the gas burners by the sudden heat to which they are exposed in lighting the gas from the top; but the balance is judged to be, on the whole, favorable to the gas. As above stated, the mirrors undergo less deterioration from gas than from the smoke of lard or oil.

Material from which light is obtained.	Number of burners to give the same quantity of light now used at Cincinnati light-house.	Cost, in cents, per night.	Cost, in dollars, per annum.	Relative cost, that of oil being 100.	Cost, per annum, for the light furnished by 2,671 oil lamps, burning at the rate of that tried by the committee.
Lard -	3.45	32.49	118.59	31.9	\$31.643
Rosin gas -	5.00	88.47	322.91	86.8	86.163
Oil -	10.01	101.95	372.12	100.	99.292.

The last column is computed from the number of lamps actually in use in the light-house establishment in 1842. (See "light-houses, beacons, and floating lights.")

At the Cincinnati prices of the several materials, admitting wood and coke to cost the same as above, the table will exhibit very considerable differences between lard and gas or oil. The rosin for a night's burning of gas would cost 11.691 cents, coke and wood 13.53 cents; and all the other expenses of the establishment being supposed the same as above, the cost, per night, for gas, comes to $27.4 + 25.22 + 24.60 + 13.70 + 4.11 = 95.03$ cents. At \$1 25 per gallon, the oil, per night, would amount to $1.113 \times 125 = 139.12$ cents; while, at 4.75 cents per pound, the lard would cost $5.602 \times 4.75 = 26.61$ cents per night.

Table of the cost of light from lard, gas, and oil, at Cincinnati prices.

Material.	Number of burners.	Cost, in cents, per night.	Cost, in dollars, per annum.	Relative cost, that of oil being 100.	Cost, per annum, for the light, equivalent to that of 2671 oil lamps.	Cost, per annum, at prices on the Atlantic, as per preceding table.
Lard -	3.45	26.61	97.13	19.13	\$25.916	\$31.643
Rosin gas -	5.00	95.03	346.85	68.31	92.553	86.163
Oil -	10.01	139.12	507.79	100.00	135.493	99.292

Hence it appears, that, at Cincinnati prices of rosin and oil, the relative cost of gas light and oil light is greatly more in favor of the former than on the Atlantic border. We are not informed as to the price paid by Government for oil on the lakes. It is probably less than the minimum quotation which we were able to find for oil at Cincinnati, and which, it will be seen, is only for winter-strained oil. From the great extension given of late to the use of oil in manufactures, for machinery, and on railroads, in this and many other countries, we do not conceive it probable that a material reduction is likely soon to take place in the price of that article, especially as there appears to be an actual falling off in its importation for

the present year, with an impression among dealers that the deficiency will continue. There is, besides, one consideration not to be lost sight of in estimating the economy in the different kinds of light. It relates to the possible future condition of the country, and the influence of that condition on the supply of the respective materials. In the case of war, should commerce become crippled, and the whale fisheries suspended, the price of oil must of necessity advance, while lard and rosin, being obtained almost exclusively from our own soil, would remain nearly as at present, or perhaps decline in price, for want of a foreign market. In such an event, we could hardly expect sperm oil to cost less, even on the Atlantic, than it now does at Cincinnati.

It is possible that our estimate for the renewal of retorts may in practice be found less than the actual expenditure. We have taken for this item the result of *experience* at the Wilmington rosin gas works. There, agreeably to the information which you had the goodness to procure, the average duration of retorts is one year, gas being made from two to three times a week,* (rather oftener than at the light-house,) and the retorts cooled after each making. It is to be remarked that the retort, or that part of it which requires to be renewed, is a single iron casting, weighing but five or six hundred pounds; and that, as all the retorts which might be required would be taken from the same pattern, they would be obtained at the lowest rates charged for similar work.

In the larger light-houses, such as those at Baker's island, Nausett beach, Sandy Hook, the Neversink, Cape Henlopen, North Point, Cape Henry, and those at the Northeast and Southwest Passes of the Mississippi, stations at which, either in one or more houses, the power of from eighteen to thirty oil lamps is employed, the relative economy of gas would be decidedly greater than at the small establishment at the mouth of the Christina. This advantage arises from the fact, that the first cost of an apparatus and gas-house, and the annual cost for repairs, would remain nearly the same for the larger as for the smaller light; and the cost of materials and retorts only would increase with the quantity of gas to be supplied. These latter items are less than one-half of the total expense. Thus, on the Atlantic, materials and waste of retorts cost 36.47 cents per night, while interest on cost of apparatus and house, and the annual allowance for repairs, cost 52 cents per night. Admitting the latter number to be increased ten per cent. for the larger establishment, and the cost of materials and retorts tripled where a 30-lamp power is required, as at Neversink and the mouths of the Mississippi, the nightly expense of gas would be 166.6 cents, that of oil 305.85 cents; or the relative cost of gas would be only 54.5 per cent. of that of oil. Admitting the renewal of retorts, grate bars, and soapstone, to cost even double as much per annum as we have estimated, there will be an economy of only four per cent. in favor of oil for a 10-lamp light-house while for a 30-lamp house it would be nearly 30 per cent. still in favor of gas. Should a more substantial building, and particularly a fire-proof structure, for the gas-house, be employed, in order to insure that great element of value in a light-house, *certainly of action*, the first cost would be considerably enhanced, but the annual repairs greatly diminished. The next point of inquiry is relative to the novelty of the

* At the New York rosin gas works, the retorts, which are *constantly* in use, last from five to eight months.

mode of generating gas at the Christiana light-house: "Whether the mode of generating the gas is an improvement, or whether it is made upon the principle generally adopted."

To this we would reply, that to make gas out of rosin, to aid the solution of this material, and to economize it by returning a part or the whole of the tar to the receptacle, is certainly no novelty. To fill the retort with fragments of coke, in order to give activity to the decomposition of the rosin, is a well-known practice. To pass the gas through a condenser, formed of upright tubes, is equally common. Some rosin gas works have used but a single upright tube of this kind, while at coal gas works very many more than Mr. Coston has applied are usually employed. The only points in which the apparatus for *making* gas appeared to vary from those elsewhere adopted are: the delivery of the rosin to the retort, near its hottest part, by means of the vertical branch; the peculiar form of the feeding apparatus at the upper end of this tube;* and the copper jacket surrounding the neck of the retort, and filled with water, kept circulating by the heat which it receives, and thus keeping the neck of the retort cool, and preventing the drying on of the tar, which would, if not thus prevented, soon clog the neck.

This plan of keeping surfaces cool by surrounding them with a case, through which water is made to circulate, is not in itself new—whether it has elsewhere been applied to the necks of gas retorts, we would not positively decide.† The feeding of the rosin by a large vertical tube, having a smaller one concentric with it, and placing the same in the hot part of the furnace, instead of feeding through a syphon altogether outside of the furnace, as is the practice in some other rosin gas works, has probably the advantage of yielding rather less tar than would otherwise be obtained. The species of tar seal used by Mr. Coston, and placed immediately above the tube of supply, keeps the melted rosin very hot, and obviates choking in the supply pipe. Beyond this, we are not aware of its being superior to the syphon used in other rosin gas works.

We refer to a communication appended to this report for the reasons assigned by Mr. Coston for declining to furnish any statements or drawing relative to the construction or novelty of his apparatus.

In reference to the two remaining topics presented in Mr. Pleasonton's letter, (*viz: the explosive nature of gas, and the incompetency of "keepers, ignorant of all the properties of gas," to manage light-houses in which it should be adopted,*) we need say but little.

The gas used for illuminating purposes is not by itself explosive. It requires a very considerable intermixture of oxygen, atmospheric air, or other gaseous matter capable of combining with its elements, to render it explosive. Such an admixture it cannot receive while it remains in the gasometer, subjected to the pressure under which it is forced out and driven through the burners. The very rare instances in which illuminating gas has been the cause of an explosion have happened by its escaping into some close apartment, becoming mixed with atmospheric air, and exploded on the approach of a light. If other reasons, therefore, urge the adoption of gas, we do not conceive that the very remote probability of an explosion, which would only happen through the most culpable negligence, ought to

* We are apprized that this substitute for the syphon has long been used at the Philadelphia gas works.

† It is believed to have been so applied at the rosin gas works in Boston.

present the least impediment to its employment, any more than the existence of the same, or rather the vastly greater, probability of the explosion of a steam boiler ought to preclude from navigation, from railroads, and from manufacturing establishments, that most important of modern agents. We do most certainly not recommend that a keeper, "ignorant of the properties of gas" be placed in charge of any light-house in which that material is to be used. Nor do we conceive that so indiscreet a procedure is either necessary or probable. The knowledge of the properties of gas, and of all that relates to its production and application, is now so generally diffused, that the Government can easily command the services of keepers competent to manage such an establishment. It would naturally suggest itself to any one who should be charged with the introduction of gas into our light-houses, to commence with those which are conveniently situated for commanding the necessary intelligence and skill to construct and manage the works, and to proceed in that gradual and cautious manner which would insure the efficacy of every arrangement and the competency of every keeper intrusted with its management.

In order to enable us the more fully to answer several of the above inquiries, we addressed to the general superintendent of light-houses in the United States a request to be furnished with some documents relative to the establishment, which he obligingly furnished, accompanying them by some remarks, which we annex by way of appendix to this report.

Other communications, already referred to, we likewise subjoin.

WALTER R. JOHNSON.

JOHN C. CRESSON.

GEORGE W. SMITH.

PHILADELPHIA, *December 16, 1844.*

APPENDIX.

TREASURY DEPARTMENT,

Fifth Auditor's Office, November 29, 1844.

SIR: I had the honor this morning to receive your letter of the 27th instant, requesting to be furnished with copies of such reports as may have been made from time to time, relative to the light-house establishment.

These reports altogether are very voluminous, and of some of them I have run out of copies. Had you stated the precise information you wished to obtain, I should probably have been able to select the report containing it.

As the report of the Committee on Commerce of the House of Representatives, made in May, 1842, contains very full information on the subject of our lights, as well as those of England and France, I have thought proper to enclose a copy of that, with a list of our light-houses, number of lamps, &c., from which I presume you will be able to gather the information you wish. Should you wish to make a comparison of the expense of oil and gas, it may be stated that our lamps consume on an average of oil about 30 gallons per lamp annually. The cost of the oil varies considerably.

In the spring of 1843, we obtained spring oil at 51 cents and winter at 58 cents; while we have been obliged to pay, for the present year's supply, in the spring from 78 to 85 cents, and the fall 90 and 93 cents per gallon.

Should you desire any further information, it will afford me pleasure to furnish it, on your signifying a wish to that effect.

I have the honor to be, respectfully, sir, your obedient servant,

S. PLEASANTON.

WALTER R. JOHNSON, Esq., *Philadelphia.*

Letter from W. R. Johnson to S. Pleasanton, Esq.

PHILADELPHIA, November 30, 1844.

SIR: I have pleasure in thanking you for copies of your tabular statement of the light-houses, beacons, and floating lights of the United States, and of the report of the Committee on Commerce on the light-house establishment, which you had the goodness to forward, accompanied by your esteemed favor of yesterday.

Should it be in your power to send a copy of Governor Davis's report, (Senate Document, 1st session 26th Congress, No. 474,) it would be an acceptable and useful addition to those already received. There is one other means of information, of which we wish to avail ourselves before deciding the general questions submitted to us in relation to the fitness or unfitness of gas for our light-houses, its economy in comparison with other kinds of light, &c.; and that is, an opportunity of inspecting the dioptric or lenticular light at the Neversink station. Should you think proper to defray, or allow Mr. Naudain to defray, the expenses of a visit to that place, it is probable that one or more of the committee might spare the time to make an inspection. An order to the proper superintendent and to the keeper would no doubt facilitate and expedite the objects of such a visit.

I am, very respectfully, your obedient servant,

WALTER R. JOHNSON.

S. PLEASANTON, Esq.

From S. Pleasanton to Walter R. Johnson.

TREASURY DEPARTMENT,

Fifth Auditor's Office, December 2, 1844.

SIR: I received this morning your letter of the 30th ultimo. Agreeably to your request, I enclose a copy of Governor Davis's report upon lenticular light-houses, made in May, 1840, (No. 474, Senate Document;) and having but two copies, I must request the favor of you to return it after perusal. That document, however, is of little value, as it is founded chiefly upon a comparative statement of Mr. Lepante, the manufacturer of the lenses, who overrated the consumption of oil in our light-houses, and underrated that of the lenses. As a proof that Mr. Lepante had underrated the consumption of oil by the lens lamps, I also enclose a report made by me to Congress in July, 1842, accompanied by a communication of Mr. Fresnel,

who is charged with the management of all the light-houses in France, and who states, from actual knowledge, the consumption of the different orders of lenses. Besides this information, the report contains much more that you will find interesting.

This information, with my remarks concerning lens lights contained in the report of the Committee on Commerce, at page 38, now in your possession, will give you pretty full and accurate information in relation to the utility and cost of lens lights.

Should the board of examiners not be satisfied with the information contained in these papers, I should be willing to defray the expenses of one of the number to the Neversink lights, for the purpose of inspecting them; though I am apprehensive, as the keeper is a new one, that he would not be able to give them any information of much value. I should be pleased to hear from you again on the subject.

I have the honor to be, respectfully, sir, your obedient servant,

S. PLEASANTON.

WALTER R. JOHNSON, Esq., *Philadelphia.*

Walter R. Johnson to Arnold Naudain, Esq.

PHILADELPHIA, November 28, 1844.

DEAR SIR: In order to complete our computation of the relative cost of different kinds of light, we find it necessary to obtain information on two or three points not found on our minutes.

1. What has been the cost of Mr. Coston's apparatus (except the building) as *now used*, and independent of the alterations made while experimenting on the subject?

2. What is the cost of the gas-house, separately?

3. How long has the retort now in use been regularly employed; what is its weight without the lid; and what its cost, including the setting?

4. When was gas first employed as a full substitute for oil? What interruptions, if any, have occurred in its use; for how long periods; and how have they been caused?

One or two queries which we desired to submit to the superintendent of the Wilmington gas works we should be glad to have answered, particularly as to the length of time the retorts are found to last, how much of the time they are in use, and how often they are cooled off.

I am, very respectfully, your obedient servant,

WALTER R. JOHNSON.

ARNOLD NAUDAIN, Esq.

Arnold Naudain, Esq., to Walter R. Johnson.

COLLECTOR'S OFFICE,

Wilmington, Delaware, December 2, 1844.

SIR: Your letter of the 28th ultimo, relating to the gas establishment at Christiana light-house, came to hand on the 29th. I was not originally

charged with the disbursements for the gas improvements at Christiana light-house. The late Secretary of the Treasury devolved the care of its construction wholly upon Mr. Coston; and until the bills of expense incident to the prosecution and completion of the work were rendered and approved, I had but little control over the matter.

The items in the bills rendered for materials for the house, and for the apparatus and fixtures, as well as for the experiments made in the progress of the work, are all blended together. The same difficulty occurs in which labor is charged. Hence the difficulty in giving definite answers to your several queries.

You will therefore perceive that the most that I can do will be to make a near approximation to the truth. The following statement is therefore respectfully submitted. In reply to your first query, "what has been the cost of Mr. Coston's apparatus, as now used?" I think I may set it down as ranging between twelve and thirteen hundred dollars.

To your 2d query, "what was the cost of the gas-house, separately?" I answer, about \$600.

Your 3d query asks, "How long has the retort now in use been regularly employed? what is its weight, exclusive of the lid; and what its cost, including its setting?" I answer, that the retort now in use is of cast iron, and has been used continually since the first of July last, with the exception of 18 nights' supply of gas, when the first chimney was taken down, and another substituted, to secure the buildings better against fire. The weight of the retort without the lid, as near as I can tell, is about 500 pounds; and the cost of the whole retort, fixtures, and setting, per bill, is \$139 09

Fourth query: "When was gas first employed as a full substitute for oil; what interruptions, if any, have occurred in its use; for how long periods, and how have they been caused?"

Gas was first employed as a substitute for oil about the 1st of May last, and has experienced no interruption, save the one of 18 days in taking down the chimney.

The queries you desired to have submitted to the superintendent of the Wilmington gas works I attended to, and am enabled to state their retorts are found to last about twelve months; that they make gas three times a week in winter, and not quite so often in summer, and cool off the retort about as often as they make gas.

I am, very respectfully, your obedient servant,

ARNOLD NAUDAIN, Esq., *Collector*,

Per JACOB B. VANDEVER, *Deputy Collector*.

WALTER R. JOHNSON, Esq., *Philadelphia*.

From Walter R. Johnson to Arnold Naudain, Esq.

PHILADELPHIA, December 3, 1844.

DEAR SIR: I am in receipt of your communication of yesterday, for which please accept my thanks.

I suppose the twelve or thirteen hundred dollars for the *apparatus* to be exclusive of the building, as I believe I expressed a desire to have it so estimated. This, with \$600 for the latter, brings the total cost of put-

ting up another establishment of the same kind to eighteen or nineteen hundred dollars. I also presume that the cost of the retort included that of making the pattern—an expense which would not have to be incurred in renewing it, or in preparing for another apparatus elsewhere. Am I right in both these points?

I suspect, also, that the cost of the retort embraces that of the cup on the top of the vertical arm, and which serves to admit the rosin. Unless this be the case, I am at a loss to understand how a casting weighing but 500 pounds could have cost \$139 09, or 27.8 cents per pound, even including the setting.

Yours, very respectfully,

WALTER R. JOHNSON.

ARNOLD NAUDAIN, Esq.

Arnold Naudain, Esq., to Walter R. Johnson.

CUSTOM-HOUSE, WILMINGTON,

December 4, 1844.

DEAR SIR: You have construed Mr. Vandever's letter correctly. The apparatus cost about \$1,200 or \$1,300, and the house about \$600.

The charge of \$139 09 includes about 870 pounds of castings, at 4 cents per pound; the cost of a pattern for retort, \$21; and the cost of workmanship in fitting it up with the cup on the vertical arm, to admit the rosin, as well as about \$9 for cast-iron weights, &c., for the counterpoise of gasometer. The bill, however, does not give the weight of the retort *separately*, with or without the lid, and 500 pounds was an *estimate* of the weight of the retort *alone*. The sum paid for fitting up the retort and setting it up at the light-house, independent of the cost of castings or pattern, was \$38 41; which, together with the cost of the castings, would be the expense of the retort, say from \$60 to \$65. The bills rendered do not distinguish the precise part of the apparatus for which the expense was incurred; and I believe the same bill includes the cost of the copper covering of the gas pipe and its connexions with the cistern, amounting to about \$15. This is the nearest approximation I can make to the cost of the retort alone, from a careful examination of the bill in which it is included. The experiment at our light-house was made under unfavorable circumstances. The work was done in winter, when the days were short, and work frequently interrupted on account of the weather. Several retorts were used, I believe two cast iron and one wrought iron, before the present one was made. There was building up and pulling down again, and rebuilding, all of which might now be avoided, with the help of our present experience; and I believe that another gas-house and apparatus, with fixtures, might be built for \$1,200 to \$1,500, of the size and efficiency of the Christiana works.

Yours, most respectfully,

ARNOLD NAUDAIN, *Collector.*

WALTER R. JOHNSON, Esq., *Philadelphia.*

Walter R. Johnson to Mr. Benjamin F. Coston.

PHILADELPHIA, December 2, 1844.

SIR : As we are now preparing the report on the Wilmington light-house, we should be glad to have, as early as may be convenient, the drawings of your apparatus, which you proposed to furnish, as well as the description of such parts as you consider to be original with yourself. Should you think proper to add the specifications of any parts modified from those which we have examined, it would, perhaps, be expedient that they should be described and figured separately.

Yours, very respectfully,

WALTER R. JOHNSON.

MR. BENJAMIN F. COSTON.

Mr. Coston to Messrs. Johnson, Cresson, and Smith.

NAVY YARD, WASHINGTON,

December 4, 1844.

GENTLEMEN : AS to so much of the instructions of the Fifth Auditor to you as relates to the amount of originality in my plan, I beg leave to say, that I deem it irrelevant to all the requisite objects of investigation, and beg leave respectfully to decline an answer. My chief object in declining to answer is, that I am now preparing to take out a patent, and it might operate prejudicially to my interests by the publication of the facts in your report. This, I hope you will see, is a precaution warranted by the circumstances of the case.

Very respectfully, your obedient servant,

BENJAMIN F. COSTON.

Professors JOHNSON, CRESSON, and SMITH.

WASHINGTON, December 24, 1844.

SIR : In support of the suggestion offered in the report on the Christiana light, of the applicability of gas consumed in Bude burners to the lenticular lights at the Neversink, I beg leave to present a few citations from a report of a select committee of the British House of Commons, a copy of which you have been so kind as to place in my hands. They show, *first*, that the burning of oil in mechanical lamps with concentric wicks is *less* economical than in ordinary Argand lamps; and, *secondly*, that burning gas in Bude burners is *more* economical than in common Argand gas burners. On the latter point, I may state that recent experiments, made in Philadelphia, are understood to confirm essentially those formerly made in London.

Extracts from the report of the Select Committee on Lighting the House.

MAY 20, 1842.

Mr. Gurney testifies : " From the concentric wick oil lamp tried at the Trinity House, they only obtained light equal to that of 9 Argand lamps, by consuming oil equal to 17 such lamps, so that light from the concentric oil Argand is nearly double the expense of the ordinary light from Argand burners."—Page 17.

Dr. Andrew Ure says : " I know of no process by which a given quantity of light for a large apartment can be produced equal to that obtained from Mr. Gurney's atmospheric Bude burner, unless at double the expense.

" I compared a Bude light in the office (No. 6 Waterloo Place) very carefully with a common Argand burner, and I found from these experiments that Mr. Gurney's burner gave at least double the light with the same consumption of gas as was obtained from a common Argand burner." Page 24.

Professor Charles Wheatstone states, that he " tried the atmospheric Bude light with the common Argand gas burner. The Bude light consumed not quite four times as much gas as the Argand burner, whilst the light given by it was six and a half times as great. For every unit of light the Bude consumed 525.6 cubic inches of gas per hour, and the Argand gas burner 900 cubic inches per hour," (showing the economical advantage of the Bude over the Argand light to be as 100 to 58.4.)

" The Waterloo Place Bude light was found equal in power to from 44 to 47 of the ordinary street lights used in that neighborhood."—Page 25.

Mr. William Keene testifies as follows : " I have kept a register for 17 days, and found the Waterloo Bude light to consume 62.8 cubic feet per hour, and assisted Professor Wheatstone in proving that it was equal to 45 street burners. Each of the street lamps should consume five cubic feet of gas per hour." " There will be double the light produced by burning 50 feet of gas in a Bude burner, to what is obtained by consuming that quantity of gas in ordinary Argand burners."—Page 26.

Doctor Neil Arnot says : " I made experiments on Mr. Gurney's new light, and on the Argand gas burner. The result was, that the larger burner burnt 5 times as much gas, and gave 8 times as much light, as the smaller or Argand."

I may remark, in conclusion, that some of the above comparisons appear to have been made on the smaller sizes of Bude burners ; in which case, the advantage would of course be found rather less than where 4 or 5 concentric rings are employed.

I am, very respectfully, your obedient servant,

WALTER R. JOHNSON.

STEPHEN PLEASANTON, Esq.

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WILLIAM H. JOHNSON

STANLEY T. JOHNSON